PG&E's Approach to Calculating MAOP

MAOP Validation and Class Location Workshop

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May 12, 2015

Agenda

- Company Overview
- Use of 49 CFR § 192.619 (for pipelines above 60 psi)
- Establishing design MAOP when features are unknown
- Role and use of pressure testing
- Final Remarks

Company Overview

- Pacific Gas and Electric Company is one of the largest combination natural gas and electric utilities in the United States.
- The company provides natural gas and electric service to approximately 15 million people throughout a 70,000-square-mile service area in northern and central California.
- Service area stretches from Eureka in the north to Bakersfield in the south, and from the Pacific Ocean in the west to the Sierra Nevada in the east.
- Approximately 6,750 miles of pipelines operating above 60 psi (scope of MAOP Validation).
- More than 42,000 miles of gas pipelines.
- 5.1 million electric customer accounts.
- 4.3 million gas customer accounts.

California Requirements

Public Utilities Code 958 requires:

- Test or replacement of untested **transmission** pipelines
- Engineering-based assumptions may be used to determine Maximum Allowable Operating Pressure (MAOP) as an interim measure

A strength test validates the MAOP.

PG&E's approach is more conservative than these requirements.

MAOP Validation

PG&E uses only 49 CFR 192.619(a) and D.11-06-017 to validate MAOP → Lowest of:

- 619(a)(1): *Design pressure* of weakest element
- 619(a)(2): Strength test pressure divided by strength test factor (*test-supported pressure*)
- 619(a)(3): Highest actual operating pressure between 1965 and 1970 (*historical pressure*)
- 619(a)(4): Maximum safe pressure

PG&E no longer relies on the “Grandfather Clause”

49 CFR 192.619(c)

Design Pressure

49 CFR 192.619(a)(1)

- 49 CFR 192.105: Design formula

  $P = (2 S t/D) \times F \times E \times T$

- 49 CFR 192.111: Design factor (*F*)
- 49 CFR 192.115: Temperature derating factor (*T*)
- D.11-06-017: Use combination of historical records and conservative engineering assumptions for *D*, *S*, *t* and long seam type (E) in accordance with PUC 958

Test-Supported Pressure

49 CFR 619(a)(2):

$$MAOP\ of\ Test = P_T/STF$$

- Strength test factor (STF) most stringent requirement of following historical requirements (at the time of the test):
  - Federal code 49 CFR
  - State code (GO 112)
  - PG&E standards

Historical MAOP

49 CFR 192.619(a)(3)

- PG&E did not use MAOP Validation effort to increase pressure beyond historical MAOP (MAOP of Record)
- MAOP of Record obtained from PG&E's MAOP catalog (created in 1979 the catalog kept track of pipeline MAOPs, included and described in March 15, 2011 filing)

Use of 49 CFR § 192.619

MAOP Validation Report

MAOP Validation Report

MAOP Report Details:

Report Date: 08/21/2014

Historic MP	Begin Measure	End Measure	Component	Year Installed	OD	WT	SMYS	Fitting Rating	Seam Type	Joint Efficiency Factor	MAOP per Design	Test Pressure	Test Year	MAOP per Test	MAOP per R	Class	% SMYS per R	Operating in Class	MAOP Limit Factor	Component MAOP
	0+00.0	0+01.0	Pipe	1991	6.625	0.2800	35000	N/A	Seamless	1.0	1479	1450	1991	966	469	! in Statio	15.9%	Y	R	469
	0+01.0	0+02.0	Pipe	1991	6.625	0.2800	35000	N/A	Seamless	1.0	1479	1450	1991	966	469	! in Statio	15.9%	Y	R	469
	0+02.0	0+03.3	Valve	1991	6.625	N/A	N/A	ANSI 400 #	N/A	N/A	960	1450	1991	N/A	469	! in Statio	N/A	Y	R	469
	0+03.3	0+04.3	Pipe	1991	6.625	0.2800	35000	N/A	Seamless	1.0	1479	1450	1991	966	469	! in Statio	15.9%	Y	R	469
	0+04.3	0+05.3	Pipe	1991	6.625	0.2800	35000	N/A	Seamless	1.0	1479	1450	1991	966	469	! in Statio	15.9%	Y	R	469
	0+05.3	0+06.2	Tee	1991	6.625	0.2800	35000	N/A	Unknown	1.0	1479	1450	1991	966	469	! in Statio	15.9%	Y	R	469
	0+06.2	0+07.7	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1430	1450	1991	966	469	2	19.7%	Y	R	469
	0+07.7	0+08.7	nsulating Join	1991	6.625	N/A	N/A	ANSI 300 #	N/A	N/A	720	1117	1991	N/A	469	2	N/A	Y	R	469
	0+08.7	0+12.4	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
	0+12.4	0+13.7	Mfg Bend	1991	6.625	0.2190	42000	N/A	Unknown	1.0	1666	1117	1991	744	469	2	16.9%	Y	R	469
	0+13.7	0+45.7	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
	0+45.7	0+46.4	Mfg Bend	1991	6.625	0.2190	42000	N/A	Unknown	1.0	1666	1117	1991	744	469	2	16.9%	Y	R	469
	0+46.4	0+47.7	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
	0+47.7	0+48.4	Mfg Bend	1991	6.625	0.2190	42000	N/A	Unknown	1.0	1666	1117	1991	744	469	2	16.9%	Y	R	469
	0+48.4	0+50.7	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
	0+50.7	0+51.4	Mfg Bend	1991	6.625	0.2190	42000	N/A	Unknown	1.0	1666	1117	1991	744	469	2	16.9%	Y	R	469
	0+51.4	0+53.7	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
	0+53.7	0+54.4	Mfg Bend	1991	6.625	0.2190	42000	N/A	Unknown	1.0	1666	1117	1991	744	469	2	16.9%	Y	R	469
	0+54.4	0+63.2	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
	0+63.2	0+64.0	Mfg Bend	1991	6.625	0.2190	42000	N/A	Unknown	1.0	1666	1117	1991	744	469	2	16.9%	Y	R	469
	0+64.0	2+51.7	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
	2+51.7	2+52.5	Mfg Bend	1991	6.625	0.2190	42000	N/A	Unknown	1.0	1666	1117	1991	744	469	2	16.9%	Y	R	469
	2+52.5	2+77.5	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
	2+77.5	7+83.0	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
	7+83.0	15+09.0	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
	15+09.0	24+26.0	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
	24+26.0	24+51.0	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1191	1117	1991	744	469	rd Road C	19.7%	Y	R	469
	24+51.0	25+57.3	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
	25+57.3	25+58.6	Mfg Bend	1991	6.625	0.2190	42000	N/A	Unknown	1.0	1666	1117	1991	744	469	2	16.9%	Y	R	469
	25+58.6	26+00.3	Pipe	1991	6.625	0.1880	42000	N/A	Electric Resistance Weld	1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
	26+00.3	26+01.6	Mfg Bend	1991	6.625	0.2190	42000	N/A	Unknown	1.0	1666	1117	1991	744	469	2	16.9%	Y	R	469

Use of 49 CFR § 192.619

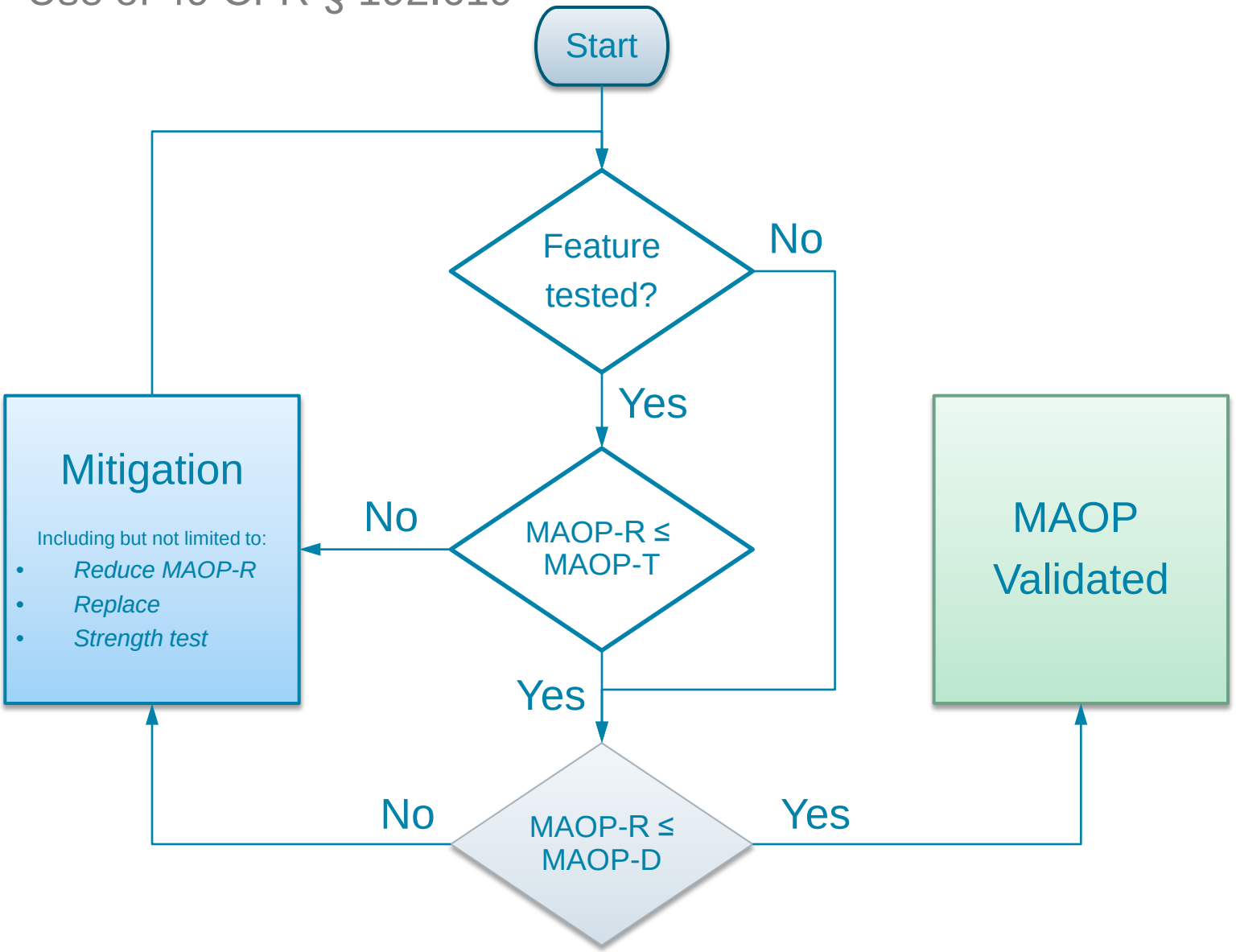
MAOP Validation Report

619(a)(1) 619(a)(2) 619(a)(3)

Report Date: 08/21/2014

Joint Efficiency Factor	MAOP per Design	Test Pressure	Test Year	MAOP per Test	MAOP per R	Class	% SMYS per R	Operating in Class	MAOP Limit Factor	Component MAOP
1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
1.0	1666	1117	1991	744	469	2	16.9%	Y	R	469
1.0	1430	1117	1991	744	469	2	19.7%	Y	R	469
1.0	1666	1117	1991	744	469	2	16.9%	Y	R	469

Use of 49 CFR § 192.619



Use of 49 CFR § 192.619

Requirements to Operate *"One Class Out"*

- Strength test meets 192.611 requirements (8h, appropriate strength test factor, etc.)
- Not uprated to be one class out

192.607	OR	192.611
• One class out in 1970 • Tested in or before 1974		• Installed in class (or in class in 1970) • Class location increased after 1970

Recent "*One Class Out*" Study

Reviewed all features operating *one class out*

Determined historical class location (parcel data, historical photography, field investigations, etc.)

- At time of install (if installed post-1970)
- In 1970 (if installed pre-1970)

"*One Class Out*" Study Results

4 categories of findings

- Feature operates one class out since 1970 (49 CFR 192.607)
- Feature operates one class out since class location change per 192.611 (post 7/1/1973)
- Feature installed out of class post 1970 (self-reported - October 9, 2014)
- Feature uprated to be out of class (self-reported - October 9, 2014)

Details of Self-Report
October 9, 2014

Installed out of class

- Example: Pipeline designed for class 1 location (72% SMYS). Analysis shows that at the time of install, there were more than 10 structures intended for human occupancy. Even if test meets requirements of 49 CFR 192.611, there was never a class location change.

Uprated to be out of class: 49 CFR 192.553(d)

- Example: Pipeline operated in class and was uprated (with test that meets 49 CFR 192.611 requirements) to be one class out.

Standardized Conservative Assumptions (Design Pressure)

Procedure for Resolution of Unknown Pipeline Features (PRUPF) TD-4199P-01

- Assumptions driven by diameter and purchase date (and other specs if known)
- Historical purchase practices
- Most conservative value based on PFL data
  - Was revised as more data was available
- Does not apply to acquired/purchased pipelines

Example: Determine SMYS

For 24” OD, SMLS pipe purchased in 1956

Nominal Pipe Size (inches)	Seam Type & Joint Factor	PURCHASE DATE See Section 3 if Purchase Date is Unknown										
		Un-known Date	Prior to 12/31/1930	01/01/1931 to 12/31/1948	01/01/1949 to 01/30/1955	01/31/1955 to 11/23/1959	11/24/1959 to 10/12/1964	10/13/1964 to 08/28/1972	08/29/1972 to 07/27/1990	07/28/1990 to 02/27/1995	02/28/1995 to 10/18/1998	As of 10/19/1998
		MINIMUM SMYS of MATERIAL (kpsi)										
24	Un-known	33 SSAW/AOS			35 SMLS/DSAW						42 S/D	35 S/D
	SSAW / AOS 0.8	33	33	33	N/A							
	SMLS 1.0	30	30	30	35	35	35	35	35	35	42	35
	DSAW 1.0	35	35	35	35	42	35	35	42	42	42	42

Assume 35 ksi SMYS

Acquired/Purchased Pipelines

- PG&E standards and historical purchase practices do not apply to pipelines acquired from other operators
- Did not apply PG&E's historical purchase practices pipeline
- Used minimum values when possible
  - Federal minimum SMYS = 24 ksi (per 192.107)
  - Minimum joint factor (0.6 and 0.8 based on diameter, per 192.113)
  - Minimum commercially available wall thickness (WT)

Field Investigations

- Performed inspections on features when conservative assumptions could not validate MAOP
- Effort was made to excavate in strategic locations to expose as many features as possible
- Performed full inspections (OD, WT, long seam characterization, non-destructive testing for yield strength, etc.)
- ***Continuing to gather field data through various activities (ILI, DA, strength tests, etc.) and using it to validate records and conservative assumptions***

Destructive Testing

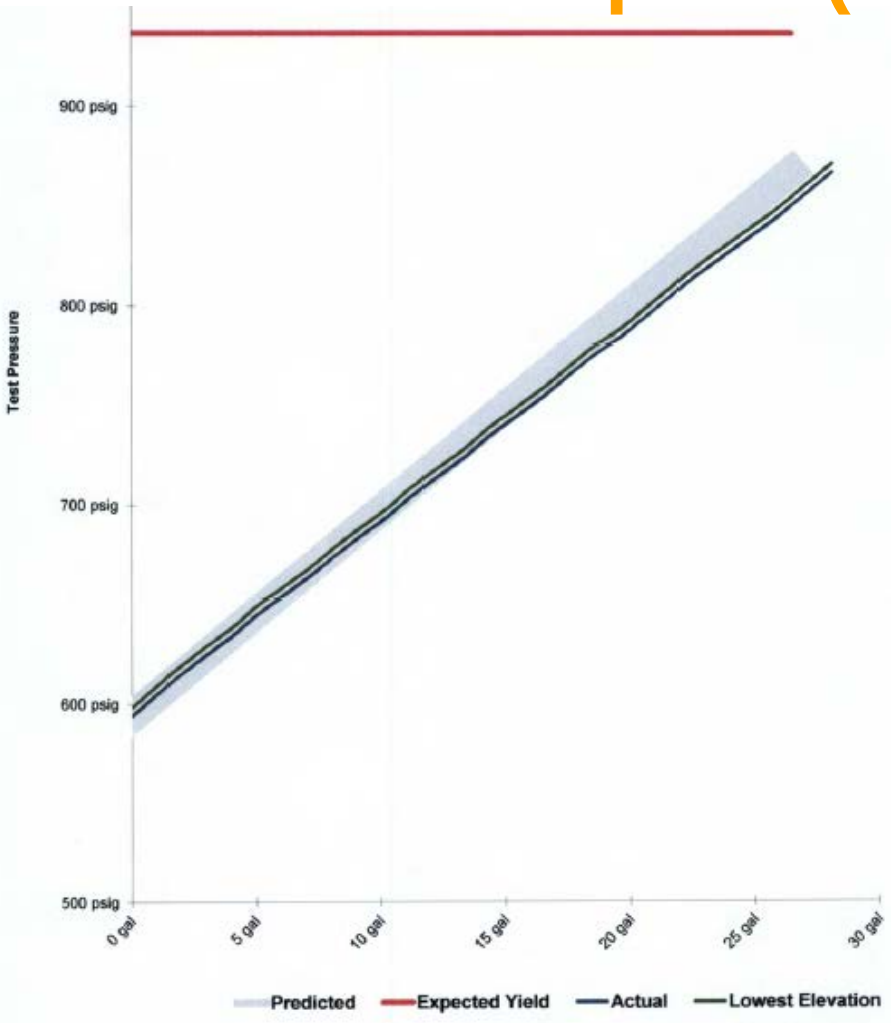
Use destructive testing to validate assumed SMYS

Example, A.O. Smith SMYS assumed to be 33,000 psi

Recent tests show assumption is conservative

Location	Date	Weld Metal Yield Strength (psi)	Parent Metal Yield Strength (psi)	Reference Number
Line 147 MP 2.2	8/19/2013	42,900	39,300	5004.9237
Line 101 MP 12.50	2/9/2015	40,200	42,100	5005.1310
Line 101 MP 12.63	4/8/2015	45,700	40,000	5005.1566

Pressure-Volume Curves to Validate Assumed Specs (3rd party)



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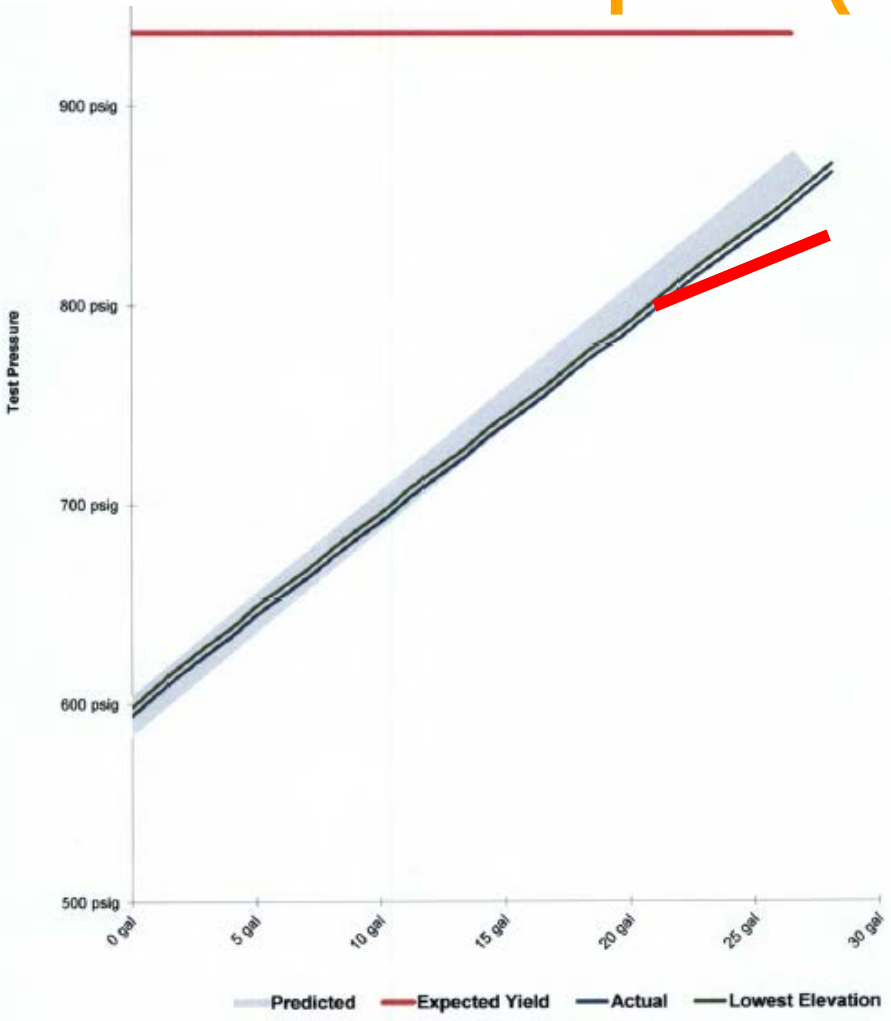

Strength Testing

- PUC 958 requires CA operators to strength test (or replace) all pipelines without traceable, verifiable and complete records of a strength test to validate historical MAOP
- PG&E is more conservative and uses the lower of 619(a)(1)-(4)

Regulatory Oversight

- PG&E has held multiple workshops with SED and has been transparent about MAOP Validation process
- MAOP Validation process and the Procedure for Resolution of Unknown Pipeline Features (PRUPF) has been reviewed by SED (as part of PSEP safety review, report issued on …)

Thank You

Vincent Tanguay